Nondestructive Evaluation of Biodegraded Oriented Strandboard: Laboratory Results

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Abstract

The durability of oriented strandboard (OSB) against biological degradation has not been clearly determined nor has an in-place assessment method been developed for OSB. The objectives of this research were to investigate the durability of OSB when exposed to wood decay fungi and to develop an in-place method for evaluating biological decay of this composite material. Southern yellow pine OSB specimens were exposed to 14 brown-rot and 8 white-rot decay fungi. Results of our initial screening revealed that the brown-rot fungus *Gloeophyllum trubeum* (Mad-617) degraded OSB to a greater extent than solid southern yellow pine wood. Stress wave nondestructive evaluation (NDE) and strength loss procedures were used to evaluate decay of OSB stakes by *G. trubeum*. Specimens showed a decrease in NDE stress wave and centerpoint flexure (modulus of rupture) values before they exhibited weight loss.

Introduction

Oriented strandboard (OSB) is widely used in residential construction. In recent years, wood composite I-joists have provided another promising market for OSB (Fig. 1), which is predicted to double in the next 5 to 7 years (1). The durability of OSB in such applications is not clearly understood. The high volume of OSB in residential structures also calls for a method for assessing the durability of OSB in service. We propose that stress wave nondestructive evaluation (NDE), proven to be a successful evaluation method for solid wood (5-9), can be successfully used to monitor composite materials. The objectives of this study were to determine the biological durability of OSB when exposed to brown- and white-rot decay fungi and to investigate the use of stress wave NDE for assessing residual strength of OSB used as a structural material.

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Materials and Methods

Decay Fungi

Fourteen brown-rot and eight white-rot wood decay fungi were screened for their capacity to degrade OSB. Samples were evaluated for decay using the American, Society for Testing and Materials (ASTM) D 1413-76 *standard method (3).* The percentage of weight loss was calculated at the end of a 12-week incubation period. Five replications were used for each fungus.

The brown-rot fungus *Gloeophyllum trabeum* (Mad-617) and the white-rot fungus *Trametes versicolor* (Mad-697) were selected for determining the rates of OSB and southern yellow pine degradation. Specimen weight was measured 0, 2, 4, 6, 8, 10, and 12 **weeks after exposure, with five replications** for each fungus. Southern yellow pine controls were used for comparison.

Gloeophyllum trabeum was inoculated on malt extract agar (MEA) (2 %) in a special incubation chamber

Figure 1. - *Use of OSB as I-joist for residential construction.*

Figure 2. - *Custom-made chamber for exposure of OSB stakes to wood decay fungi,.*

(Fig. 2), placed in a 27°C incubation room at 70 percent relative humidity, and allowed to grow for 7 days to obtain confluent growth before the OSB stakes (12.7 by 25.4 by 305 mm) were added.

Nondestructive Evaluation

Ten replicate stakes were removed from the incubation chamber, and the percentage of weight loss was calculated after 0, 2, 4, 6, 8, or 11 weeks. Waveform was used to evalate stress wave behavior (Fig. 3). Control OSB samples were not exposed to the fungi.

Strength Test

Centerpoint flexure tests were performed on OSB stakes harvested at each time point using a Tinius Universal Testing machine according to ASTM D 3043-95 (2). Data for modulus of rupture (MOR) and modulus of elasticity (MOE) were collected.

Results and Discussion

Weight loss of OSB after a 12-week exposure to wood decay fungi is shown in Table 1. In general, the brown-rot fungi caused more degradation and greater weight loss than did the white-rot fungi. The rate of OSB and solid wood degradation by brown- and white-rot fungi is shown in Figure 4. The structure and design of OSB lead to large voids, which provide abundant paths for fungal hyphae to penetrate and degrade the wood (4). Therefore, faster and more extensive degradation of OSB was expected.

Figure 5 shows NDE results for OSB stakes at different time intervals. Waveforms of controls and degraded specimens were markedly different. The control waveform consisted of a series of equally spaced pulses whose magnitude decreased with time. The percentage of weight loss was calculated at the end of each time

Figure 3. - *NDE unit used for measuring stress waves.*

point. Weight gain at week 2 was caused by moisture gain during incubation (Fig. 6); weight loss was gradual after 2 weeks of exposure and dramatic after 6 weeks. The curve of the reciprocal of stress wave frequency revealed incipient decay at week 2. These results show promise for NDE as a laboratory detection technique for assessing fungal damage of OSB.

Decrease in the reciprocal of stress wave frequency and MOR with time is shown in Figure 7. Strength loss of OSB corresponded with stress wave frequency. The results indicate that NDE would be effective in future field studies on assessing the residual strength of full-size OSB structural composites.

Concluding Remarks

In general, brown-rot fungi degraded OSB to a greater extent than did white-rot fungi. The rate of degradation was the same as that of solid wood, but higher weight loss was obtained with OSB. Stress wave NDE values

Table 1. - *Effect of decay fungi on OSB.*[a]

Fungus	Weight loss
	(%)
Brown-rot	
Antrodia serialis (FP-104443)	15.8 ± 10.1
Antrodia vaillantii (FP-90877-R)	20.1 ± 2.0
Antrodia xantha (Mad-5096-35)	36.4 ± 5.1
Antrodia carbonica (HHB-5104)	45.3 ± 6.1
Coniophora puteana (Mad-515)	34.2 ± 5.2
Fomitopsis meliae (FP-105065-sp)	58.4 ± 1.4
Gloeophyllum trabeum (Mad-617)	49.0 ± 2.7
Laetiporus sulphureus (SH-27-R)	20.3 ± 3.2
Leucogyrophana arizonica (RLG-9902-sp)	36.7 ± 4.9
Leucogyrophana olivascens (FP-104339-sp)	50.6 ± 4.8
Meruliporia incrassata (Mad-563)	19.8 ± 4.2
Neolentinus lepideus (Mad-534)	52.7 ± 21
Postia placenta (Mad-698)	42.9 ± 5.4
Serpula himantoides (FP-97367)	42.8 ± 3.4
White-rot	
Trametes versicolor (Mad-697)	53.3 ± 1.8
Ganoderma upplanatum (HHB-7823-s)	37.3 ± 3.7
Irpex lacteus (HHB-7328-sp)	25.8 ± 4.9
Phanerochaete chrysosporium (ME-461)	0.2 ± 0.4
Phellinus ferrigineofuscus (MJL-1357-sp)	16.7 ± 1.4
Phellinus pini (L-14602-sp)	30.2 ± 3.1
Phlebia brevispora (HHR-7030)	16.7 ± 1.2
Pycnosporus sanguineus (FP-103380-sp)	1.8 ± 1.5

[a] Standard method of testing wood preservatives by laboratory soil-block cultures, ASTM D 1413-76.

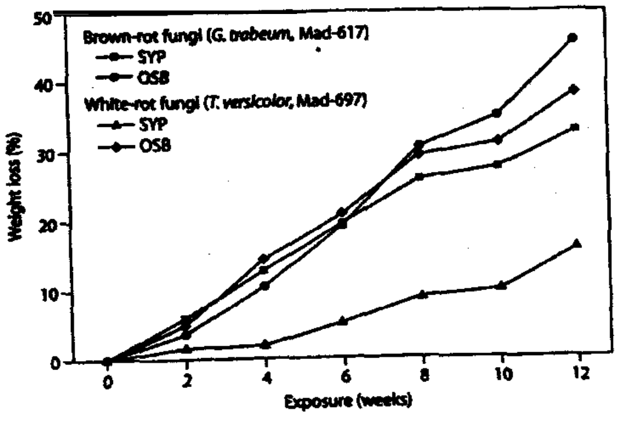

Figure 4. - *Rate of fungal degradation of OSB and solid wood.*

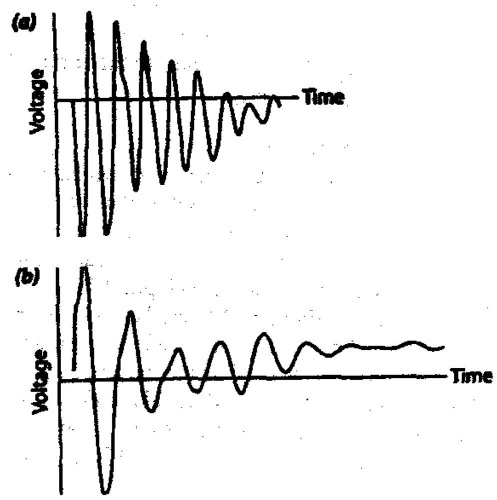

Figure 5. - *NDE representive waveforms for control (a) and degraded (b) OSB.*

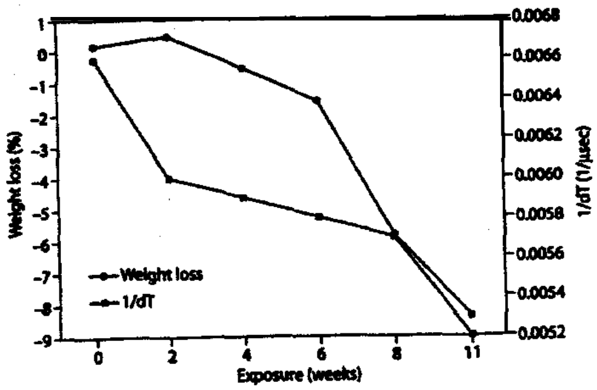

Figure 6. - *Comparison of weight loss and stress wave frequency for degraded 0SB.*

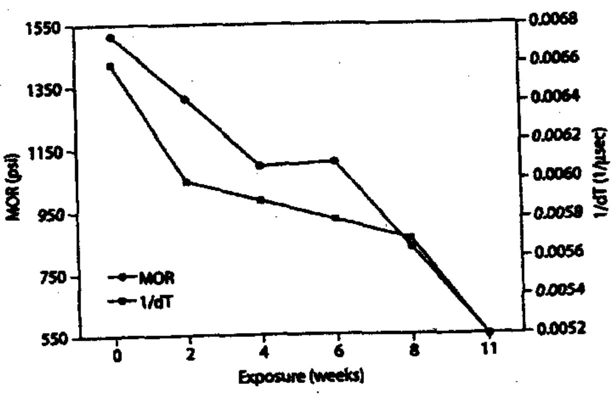

Figure 7. - *Comparison of stress wave frequency and MOR for degraded OSB.*

and flexure test results detected decay earlier than did weight loss measurement. We conclude that NDE can be used effectively as an in-place assessment method for evaluating the strength of OSB.

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Proceedings of the 2nd Annual Conference on
Durability and Disaster Mitigation in Wood-Frame Housing

November 6-8, 2000
Monona Terrace Convention Center
Madison, Wisconsin

This conference was sponsored by the PATH Consortium for Wood-Frame Housing in cooperation with the Forest Products Society. The *PATH Consortium for* Wood-Frame *Housing is made up of the National Planning Committee for Forest Products (consisting of the Forest Products Laboratory, USDA Forest Service; universities with forest products programs; and USDA Cooperative State Research, Education, and Extension services); the American* Forest *& Paper Association (AF&PA); APA-The Engineered Wood Association; and the National Association of Home Builders Research Center (NAHBRC).*

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